

Claims:

Having thus described our invention, we claim:

1. A unitary filter cartridge to be removably and sealingly received within a circular opening through a tube sheet separating the clean and dirty plenums of filtration apparatus, said tube sheet having an upper surface, a cylindrical mouth surface and a lower surface, said filter cartridge comprising:

a filter sleeve formed as a tubular member having an open upper end oriented toward said tube sheet and an open lower end oriented away from said tube sheet;

a tubular screen positioned interiorly of said filter sleeve for structural support thereof, said tubular screen having an open upper end oriented toward said tube sheet and an open lower end oriented away from said tube sheet;

a bottom end cap sealingly secured to the lower end of said filter sleeve to close said lower end of said filter sleeve; and

a unitary tubular, upper fitting including an upper flange extending above said tube sheet, a tube sheet mouth insert, a contoured transition and a lower cylindrical collar extending beneath said tube sheet all integrally formed of flexible, resiliently deformable material, said lower cylindrical collar of said fitting permanently securing said upper end of said filter sleeve, and said upper flange of said fitting overlying said tube sheet adjacent said circular opening to suspendingly support the filter cartridge from said tube sheet;

whereby, when said filter cartridge is installed in said tube sheet, said fitting deformably contacts said tube sheet on at least portions of the three tube sheet surfaces to affect sealing engagement therewith such that at least a portion of said flange of said fitting seals with at least a portion of said upper surface of said tube sheet adjacent said circular

opening, said tube sheet mouth insert of said fitting seals with said cylindrical mouth surface of said tube sheet, and at least a portion of said contoured transition of said fitting seals with at least a portion of said lower surface of said tube sheet adjacent said circular opening.

2. The unitary filter cartridge as in Claim 1, wherein said fitting is configured to satisfy a relation $0.3 < H/D < 0.85$; wherein D represents the diameter of said circular opening through said tube sheet and H represents a distance between the upper end of said filter sleeve and said circular opening through said tube sheet.

3. The unitary filter cartridge as in Claim 1 wherein, upon installation of said filter cartridge in said tube sheet, said contoured transition of said fitting includes a diameter slightly greater than the diameter of said circular opening to affect sealing engagement with at least a portion of said lower surface of said tube sheet and contours therefrom to a diameter less than or equal to the diameter of said circular opening integrally joining said lower cylindrical collar of said fitting.

4. The unitary filter cartridge as in Claim 3 wherein, prior to installation of said filter cartridge in said tube sheet, said contoured transition of said fitting being formed exteriorly in a frusto-conical vertical cross-section including a diameter greater than the diameter of said circular opening and being formed interiorly in a substantially uniform cylindrical vertical cross-section;

whereby, during installation, said transition is resiliently deformed inwardly to pass through said circular opening of said tube sheet and then deflects outwardly to affect sealing engagement with at least a portion of said lower surface of said tube sheet.

5. The unitary filter cartridge as in Claim 3 wherein, prior to installation of said filter cartridge in said tube sheet, said contoured transition of said fitting being formed interiorly in a frusto-conical vertical cross-section and exteriorly in a substantially uniform cylindrical vertical cross-section with a diameter less than or equal to the diameter of said circular opening;

whereby, during installation, said transition is passed through said circular opening of said tube sheet and then resiliently deformed outwardly to affect sealing engagement with at least a portion of said lower surface of said tube sheet.

6. The unitary filter cartridge as in Claim 5, further comprising a tubular expander with an insertable band including an outer diameter substantially equal to or less than the inner diameter of said upper flange of said upper fitting, said band configured to engage interiorly said frusto-conical portion of said contoured transition of said fitting proximate said circular opening through said tube sheet to outwardly bias portions of the resiliently deformable fitting to affect sealing engagement with said cylindrical mouth surface of said tube sheet and with at least a portion of said lower surface of said tube sheet adjacent said circular opening.

7. The unitary filter cartridge as in Claim 6, said frusto-conical portion of said contoured transition of said fitting having an innermost diameter smaller than the largest diameter of said insertable band of said tubular expander whereby said band causes portions of said contoured transition to bulge outwardly beneath said tube sheet to affect sealing engagement with at least a portion of said lower surface of said tube sheet adjacent said circular opening.

8. The unitary filter cartridge as in Claim 7, said insertable band comprises a cylindrical vertical wall having a diameter larger than the innermost diameter of said frusto-conical portion of said contoured transition of said fitting to cause portions of said contoured transition to bulge outwardly beneath said tube sheet to affect sealing engagement with at least a portion of said lower surface of said tube sheet adjacent said circular opening.

9. The unitary filter cartridge as in Claim 7, said insertable band comprises a funnel wall tapering from a larger upper diameter, which is substantially equal to or less than the inner diameter of said upper flange of said upper fitting, to a smaller lower diameter, which is larger than the inner diameter of said filter sleeve; said funnel wall having an intermediate diameter larger than the innermost diameter of said frusto-conical portion of said contoured transition of said fitting to cause portions of said contoured transition to bulge outwardly beneath said tube sheet to affect sealing engagement with at least a portion of said lower surface of said tube sheet adjacent said circular opening.

10. The unitary filter cartridge as in Claim 7, said insertable band comprises: (a) a cylindrical vertical wall having a diameter larger than the innermost diameter of said frusto-conical portion of said contoured transition of said fitting to cause portions of said contoured transition to bulge outwardly beneath said tube sheet to affect sealing engagement with at least a portion of said lower surface of said tube sheet adjacent said circular opening; and (b) a circumferential groove in said cylindrical vertical wall to receive therein a portion of said frusto-conical portion of said contoured transition of said fitting.

11. The unitary filter cartridge as in Claim 6, said tubular expander further including a flange ring integrally joined to the upper end of said insertable band to overlie said upper flange of said upper fitting when said filter cartridge is installed in said tube sheet to affect sealing engagement between at least a portion of said flange of said fitting with at least a portion of said upper surface of said tube sheet adjacent said circular opening.

Sub. C1
12. The unitary filter cartridge as in Claim 11, said upper flange of said fitting having an outermost circumferential edge with voids therein to provide a tool access between the flange ring of said expander and the upper surface of the tube sheet to facilitate removal of said expander from engagement with said upper fitting for removing said filter cartridge from said tube sheet.

13. The unitary filter cartridge as in Claim 12, said upper flange of said fitting having a circumferential scallop edge with uniformly spaced voids to provide a tool access between the flange ring of said expander and the upper surface of the tube sheet to facilitate removal of said expander from engagement with said upper fitting for removing said filter cartridge from said tube sheet.

Sub. C2
14. The unitary filter cartridge as in Claim 1, said bottom end cap sealingly secured to the lower end of said filter sleeve comprising a substantially cylindrical disk having an outside diameter greater than the diameter of said filter sleeve and being formed of flexible, resiliently deformable material, and a circumferential groove in said cylindrical disk which extends inwardly from the outside diameter of said disk to diameter at the bottom of said groove which corresponds to the outside diameter of said filter sleeve to concentrically align said filter sleeve with respect to said bottom end cap.

15. The unitary filter cartridge as in Claim 14, said bottom end cap further comprising a lower surface which extends beneath the lowermost end of said filter sleeve, and vertical grooves which extend upwardly from said lower surface to the lowermost end of said filter sleeve to vertically position said filter sleeve with respect to said bottom end cap.

16. The unitary filter cartridge as in Claim 15, said bottom end cap further comprising radial grooves which extend upwardly from said lower surface to the lowermost end of said tubular screen to vertically position said tubular screen with respect to said bottom end cap.

add C3